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AN ESTIMATE OF THE DIMENSIONS OF THE LAKE CHAMPLAIN MONSTER FROM THE LENGTH OF ADJACENT WIND WAVES IN THE MANSI PHOTOGRAPH

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ABSTRACT: Empirical results relating the appearance of the sea surface to wind speed and thence to the length of wind waves are used to provide an estimate of the dimensions of "Champ," as seen in the Mansi photograph. Over the possible ranges of wind speed and fetch, lower and upper bounds for the water-line dimension of "Champ" range from 4.8 m to 17.2 m.

INTRODUCTION

A problem which commonly arises in the interpretation of images of unfamiliar objects on water is that of determining their size. In the absence of nearby reference features, the eye cannot estimate absolute dimensions reliably. Too often, even when photographs are available, neither the geometry of the situation nor the optical properties of the camera are known with sufficient accuracy to deduce scales from triangulation. An example in point is the color Instamatic photograph of the Lake Champlain Monster ("Champ") taken by Sandra Mansi in 1977, appearing here as Fig. 1. A sketch based on the photograph appears as Fig. 2. Color reproductions of the original photograph have been published in *Time* (July 13, 1981) and in *Life* (August, 1982); black and white versions have appeared in *The New York Times* (June 30, 1981) and in *The ISC Newsletter* (Vol. 1, No. 2). Neither the features of the far shore, nor the shrubs appearing in the foreground, are suitable as a scale for the object seen in the water.

This paper discusses the use of a different scale, which may sometimes be used in scenes of the water surface. It is shown here how, from the general appearance of the water surface, it may be possible to estimate the length of waves seen thereon, and hence to use the latter as a scale with which to compare objects of uncertain dimensions. The method is applied to the Mansi photograph.

METHOD

Mariners estimate wind speed from the appearance of the sea surface through the Beaufort scale (Table 1). Each level in that scale is associated with visually distinguishable features of the sea surface. The first step in this method thus consists of deciding on a Beaufort Scale number corresponding to the conditions observed. This step yields a range of possible wind speeds.

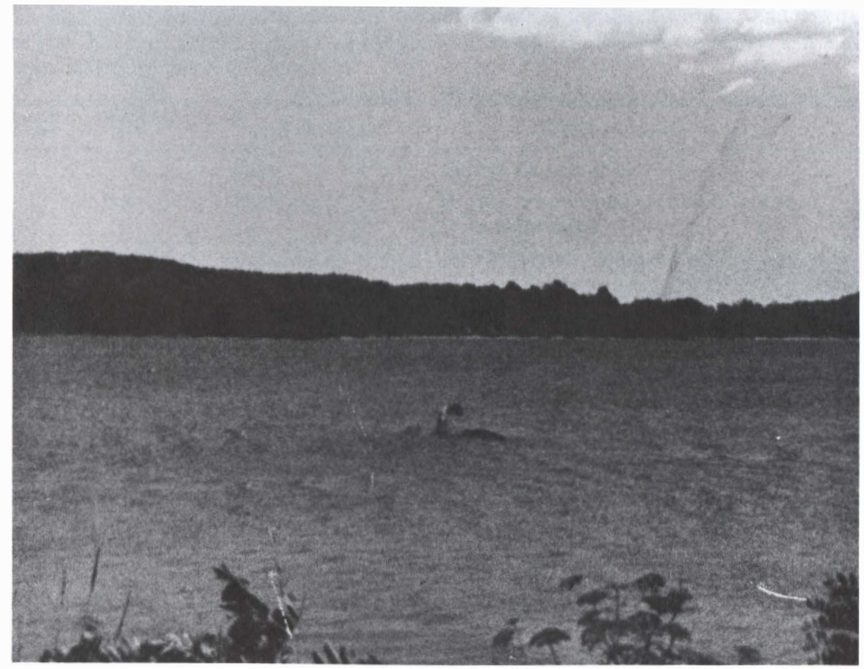

FIG. 1.—Photograph of the Lake Champlain Monster taken by Sandra Mansi in 1977 with an Instamatic camera (original in color).

The properties of wind waves depend on the speed and duration of the wind, and on the fetch over which it has been blowing. Waves may be fetch-limited or duration-limited, depending on which of these two factors impose a limit on their size. Empirical results relating the significant wave period T_s and wave height H_s to fetch F and wind speed U are given in a number of sources (Wiegel 1964, U.S. Army 1973, Van Dorn 1974). A graphical form of these relations is shown in Fig. 3. Knowing fetch and wind speed, one must first estimate the wind duration t_{min} below which the waves are duration-limited. If the wind has blown for a time $t > t_{min}$, the period T_s and the wave height H_s are read from the appropriate curves as functions of the parameter gF/U^2. Should t be less than t_{min}, however, a shorter fetch F^* is used, related to F through $F^* = Ft/t_{min}$; wave height and period are then calculated from gF^*/U^2.

The wavelength λ depends in general on the water depth D, as well as on wave period T_s. Provided the water is not too shallow, however, i.e., not less than about one third of a wavelength, the depth dependence is unim-

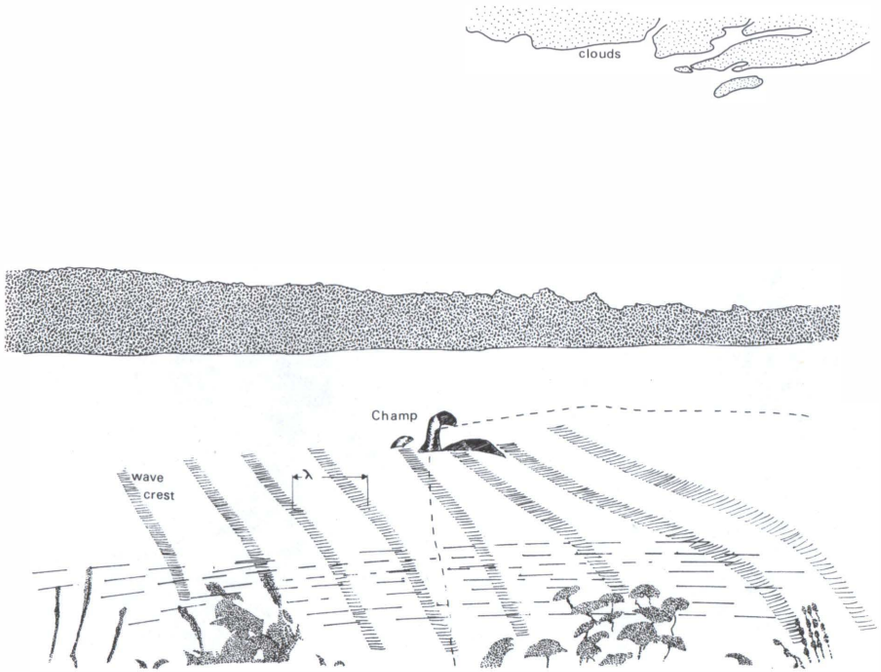

FIG. 2.—A sketch of the Mansi photograph of Champ emphasizing the waves visible at the water surface. See text for explanation of symbols.

portant, and one may use the approximate expression (LeBlond and Mysak 1978):

$$\lambda = gT_s^2/2\pi.$$

The final step in the procedure consists of comparing the horizontal extent of the unknown object at the water line with the length of the waves in its immediate vicinity.

Sources of error may appear at many stages of the estimation method, and this must be kept in mind when interpreting the results. First of all, the Beaufort scale determines only a *range* of wind speeds. Secondly, there is some possibility of error in the fetch estimate if the wind direction is not known with certainty, or if the exact position of the observation is not precisely determined. The duration of the wind may not be available, with possible consequences on the effective value of fetch which enters the calculations. Finally, wind waves are quite variable in their length and height, and although the significant wave height and period correspond closely to visually observed wave properties, they are average estimates: individual

TABLE 1.—The Beaufort wind scale and the appearance of the sea at various wind speeds. The scale has been truncated here to the lower wind speeds; continuation to storms and hurricanes may be found in Gross (1977).

Beaufort number	Wind speed (m/sec)	Wind description	Appearance of the water surface
0	0	Calm	Surface like a mirror
1	0.3–1.5	Light air	Ripples with the appearance of scales; no foam crests
2	1.6–3.3	Light breeze	Small wavelets; crests of glassy appearance, no breaking
3	3.4–5.4	Gentle breeze	Large wavelets; crests begin to break; scattered whitecaps
4	5.5–7.9	Moderate breeze	Small waves, becoming longer; numerous whitecaps
5	8.0–10.7	Fresh breeze	Moderate waves, taking longer form; many whitecaps; some spray
6	10.8–13.8	Strong breeze	Large waves begin to form; whitecaps everywhere; more spray
7	13.9–17.1	Near gale	Sea heaps up and white foam from breaking waves begins to be blown in streaks
8	17.2–20.7	Gale	Moderately high waves of greater length; edges of crests begin to break into spindrift; foam is blown in well-marked streaks
9	20.8–24.4	Strong gale	High waves; dense streaks of foam; spray may affect visibility

waves will vary about these averages, and this variability should be taken into account when comparing the dimensions of the object with that of the waves.

RESULTS

The main features of the Mansi photograph are reproduced in sketch form in Fig. 2. The sketch was drawn from an enlargement of the original print, and emphasizes the principal water waves seen in the field of view. Two main groups of waves are discernible. The dominant waves, in terms of height and length, have crests running nearly perpendicular to shore. The appearance of the wave crests and the position of the few breakers indicate that the waves propagate from left to right. The other group of waves, smaller in height and shorter in length, have crests nearly parallel to shore; they appear to result from the scattering of the wind waves from an irregular shoreline. There is no clear indication of waves produced by Champ itself.

The lower right hand quadrant of the photograph appears lighter than the

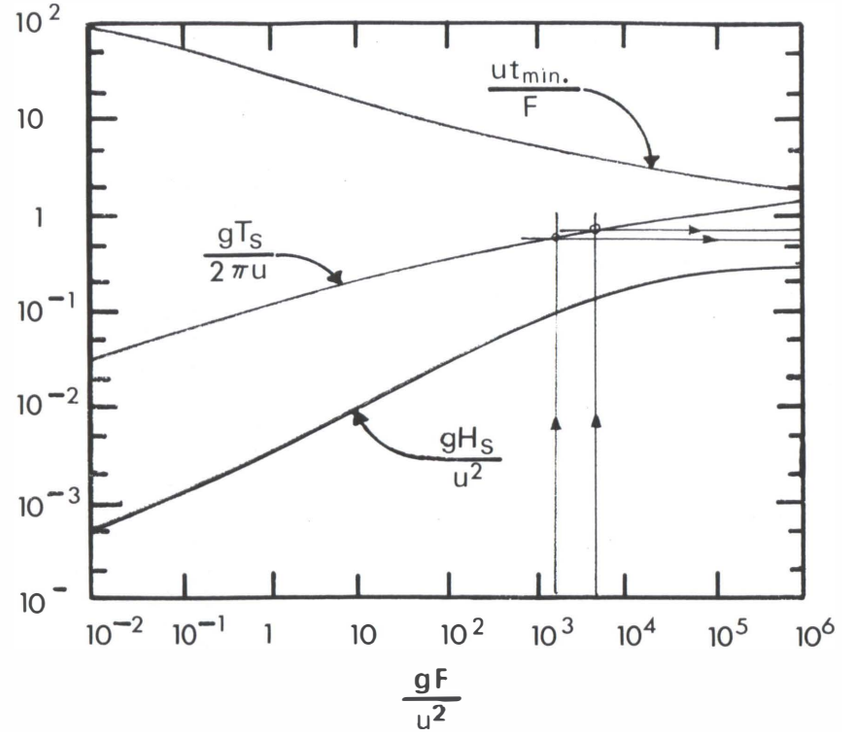

FIG. 3.—Empirical relations between wave properties, wind speed U and fetch F. H_s and T_s are the significant wave height and period respectively; t_{min} is the wind duration below which the waves are duration- rather than fetch-limited. The method of evaluation of T_s from gF/U^2 for the range of F considered in the text and the higher wind speed estimate is sketched in. For greater accuracy, the equation

$$\frac{gT_s}{2\pi U} = 1.2 \tanh[0.077(gF/U^2)^{0.25}]$$

may be used instead of the curve. From Sarpkaya and Isaacson (1981).

rest of the lake surface; this area is roughly bounded by the dashed line in Fig. 2. Although it might be argued that this feature reveals the presence of a relatively shallow sandy area in that part of the lake, this hypothesis is inconsistent with the behavior of the waves travelling over that area. In the other parts of the photograph, waves are seen to be breaking at a few isolated spots and the surface shows the characteristics associated with Beaufort Number 3 (Table 1). As waves travel into shallower water, they slow down, steepen, and eventually break. If the paler area corresponded to the presence of a shallow sand bank, one would expect the waves to be modified, and

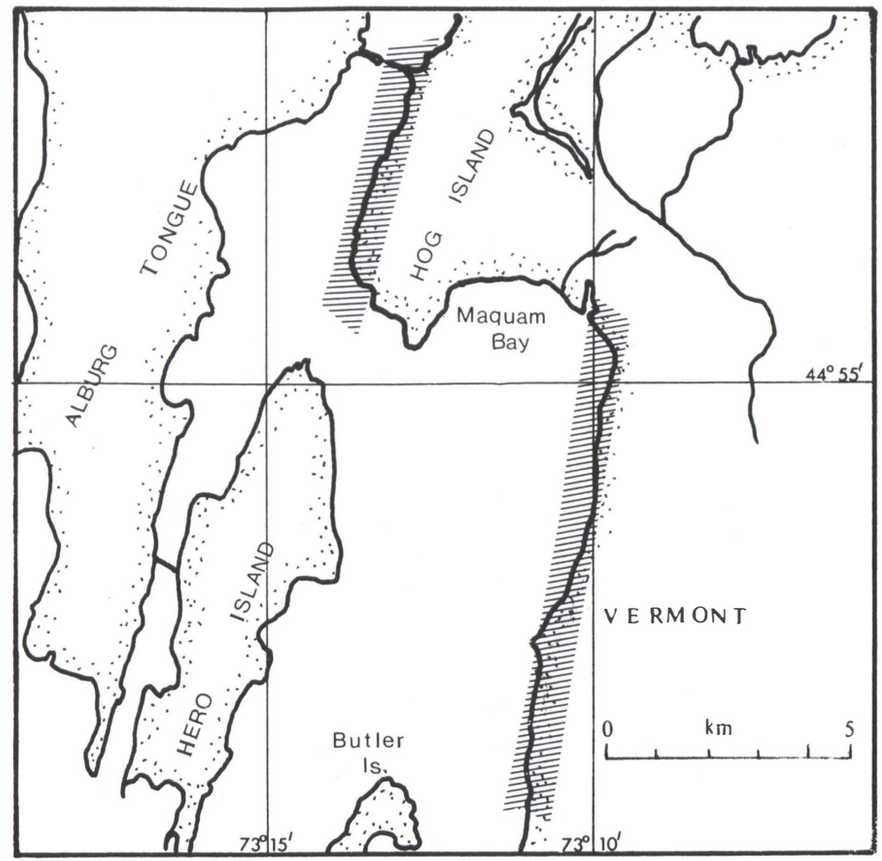

FIG. 4.—The northeast corner of Lake Champlain, from just north of St. Albans Bay, Vermont (below the right hand corner of the map) to the Canadian border, drawn from NOAA map 14781. Stretches of shoreline from which the Mansi photograph may have been taken are shown by a shaded strip.

particularly to break more often there than elsewhere. This is not the case, and it seems more reasonable to attribute the different appearance of that part of the lake surface to reflection of light from the overhead clouds.

The exact location from which the Mansi photograph was taken has not been precisely determined. Interviews with Mr. and Mrs. Mansi (R. Greenwell and R. Mackal, priv. comm., Sept., 1982) reveal that the picture looks generally westwards, from the eastern shore of the northeast part of Lake Champlain, north of St. Albans Bay, Vermont, but south of the Canadian border (Fig. 4), and that the Mansis had to walk about 100 meters across a field to gain access to the lake from the road on which they were driving.

Roads follow the shoreline on the Vermont side from opposite Butler Is. to Maquam Bay, and along part of the west side of Hog Island. Possible fetches from the southern quadrant thus range from about 5 to 15 km.

Given that possible range of fetches, the parameter gF/U^2 takes values ranging from 4,200 to 21,200 for the lower wind speed estimate (3.4 m/sec), and from 1,700 to 5,000 for the higher wind speed (5.4 m/sec) of Beaufort wind scale 3. From the upper curve of Fig. 3, we find that the range of value of t_{min}, the wind duration below which the waves are duration-limited, is from 1.0 to 3.0 hours for both the lower and the higher wind speed. This duration is short enough that we can assume, in the absence of any other information, that the waves are fetch- and not duration-limited. There is thus no need to correct the fetch, as discussed above, and using the middle curve in Fig. 3, we obtain the periods T_s and (from the equation quoted earlier), the wavelength λ of the fetch-limited waves. For the lower wind speed (U = 3.4 m/sec), λ ranges from 3.2 m to 5.5 m; for the higher wind speed (U = 5.4 m/sec), λ takes values from 5.4 m to 8.6 m, as the fetch increases from 5 to 15 km. Over the whole gamut of expected wind speeds and fetches, the wavelength can range from 3.2 to 8.6 m. From Fig. 2, Champ stretches from 1.5 to 2 wavelengths at the water line: this dimension thus ranges from an extreme lower bound of 4.8 m to an extreme upper bound of 17.2 m.

Discussion

The range of water line dimensions obtained for Champ is quite broad because the conditions under which the photograph were taken are not known very accurately. If the fetch were known accurately, the ratio of upper to lower bound in wavelength could be reduced by a factor of two. There always remains, however, a range of uncertainty associated with estimating the wind speed through the Beaufort scale, as well as some uncertainty (due to the natural variability of the waves) in determining the scale of the object in term of number of wavelengths.

The inescapable conclusion, nevertheless, is that the object seen in the Mansi photograph is of considerable size. The visual estimate given by Mr. Mansi (15 to 20 feet: 4.6 to 6.1 meters at the waterline) falls within the lower part of the length range estimated here, and provides independent confirmation of this conclusion.

References Cited

Gross, M. G.
1977 *Oceanography: A View of the Earth* (2nd Ed.). Englewood Cliffs, N.J.: Prentice-Hall.
LeBlond, P. H., and L. A. Mysak
1978 *Waves in the Ocean.* Amsterdam: Elsevier.

Sarpkaya, T., and M. Isaacson
1981 *Mechanics of Wave Forces on Offshore Structures.* New York: Van Nostrand Reinhold.
U.S. Army, Corps of Engineers
1977 *Shore Protection Manual* (3rd Ed.). Coastal Engineering Research Center, Fort Belvoir, Va. Washington, D.C.: U.S. Govt. Printing Office.
Van Dorn, W. G.
1974 *Oceanography and Seamanship.* New York: Dodd, Mean & Co.
Wiegel, R. L.
1964 *Oceanographical Engineering.* Englewood Cliffs, N.J.: Prentice-Hall.